A

AQA

Surname ______________________________

Forename(s) ______________________________

Centre Number ______________________________

Candidate Number ______________________________

Candidate Signature ______________________________

I declare this is my own work.

# GCSE

# CHEMISTRY

# H

**Higher Tier Paper 2**

# 8462/2H

**Tuesday 13 June 2023 Morning**

**Time allowed: 1 hour 45 minutes**

**At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.**

**[Turn over]**

J U N 2 3 8 4 6 2 2 H 0 1

**MATERIALS**

**For this paper you must have:**

- **a ruler**
- **a scientific calculator**
- **the periodic table (enclosed).**

## INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Pencil should only be used for drawing.**
- **Answer ALL questions in the spaces provided. Do not write on blank pages.**
- **If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).**
- **Do all rough work in this book. Cross through any work you do not want to be marked.**
- **In all calculations, show clearly how you work out your answer.**

## INFORMATION

- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

**DO NOT TURN OVER UNTIL TOLD TO DO SO**

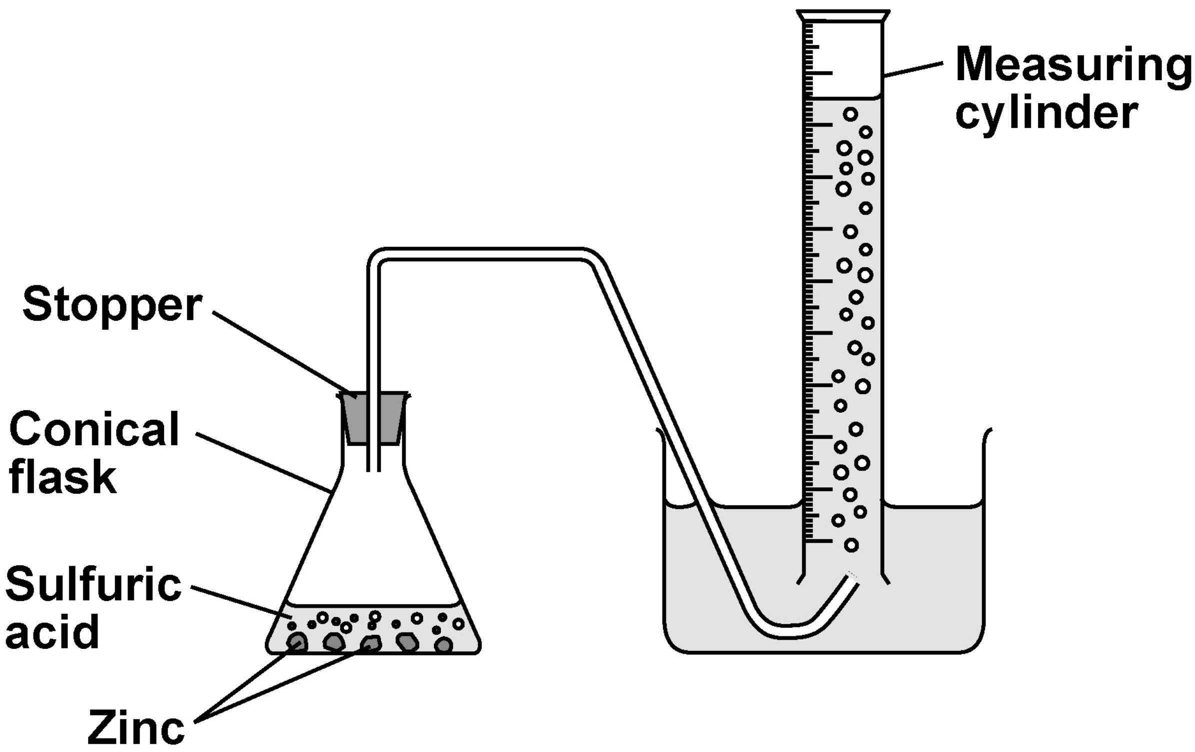
**0 1**

**A student investigated the rate of the reaction between zinc and sulfuric acid.**

**Hydrogen gas is produced during this reaction.**

**FIGURE 1 shows the apparatus.**

**FIGURE 1**



This is the method used.

1. Add 50 $cm^3$ of sulfuric acid to a conical flask.
2. Add 2.0 g of zinc to the conical flask.
3. Quickly put a stopper in the conical flask and start a timer.
4. Measure the time taken to collect 20 $cm^3$ of gas.
5. Repeat steps 1 to 4 three more times.

**0 1 . 1**

Suggest why the stopper must be put in the conical flask as quickly as possible in STEP 3. [1 mark]

[Turn over]

**0 1 . 2**

**The student calculated the rate of the reaction for each trial.**

**TABLE 1 shows the results of the calculations.**

**TABLE 1**

| | TRIAL 1 | TRIAL 2 | TRIAL 3 | TRIAL 4 |
|---|---|---|---|---|
| Rate of reaction in $cm^3/s$ | 0.78 | 0.81 | 0.68 | 0.81 |

**Determine the mean time taken to collect 20 $cm^3$ of gas.**

**Do NOT include any anomalous results.**

**Use the equation:**

$$\text{mean rate of reaction} = \frac{\text{volume of gas collected}}{\text{mean time taken}}$$

**[5 marks]**

Mean time taken = ______________________________ s

[Turn over]

**0 1 . 3**

**The student changed the investigation so that the mean time taken to collect 20 $cm^3$ of gas was greater.**

**Which TWO changes would increase the mean time taken to collect 20 $cm^3$ of gas? [2 marks]**

**Tick (✓) TWO boxes.**

- [ ] Use a catalyst
- [ ] Use a larger conical flask
- [ ] Use a lower temperature
- [ ] Use smaller pieces of zinc
- [ ] Use sulfuric acid of a lower concentration

**0 1 . 4**

**Hydrogen gas is produced during this reaction.**

**Describe the test for hydrogen gas.**

**Give the result of the test. [2 marks]**

**Test** ____________________________________________

____________________________________________

____________________________________________

**Result** ____________________________________________

____________________________________________

____________________________________________

**[Turn over]**

**10**

**0 2**

**This question is about alcohols and carboxylic acids.**

**Alcohols are used as fuels.**

**A student burned 1.00 g of six alcohols and determined the energy released from each.**

**TABLE 2 shows the results.**

**TABLE 2**

| Alcohol | Formula of one molecule of the alcohol | Energy released in kJ/g |
|---|---|---|
| Ethanol | $C_2H_5OH$ | 29.6 |
| Propanol | $C_3H_7OH$ | 33.6 |
| Butanol | $C_4H_9OH$ | 36.1 |
| Pentanol | $C_5H_{11}OH$ | 37.7 |
| Hexanol | $C_6H_{13}OH$ | 38.9 |
| Heptanol | $C_7H_{15}OH$ | 39.8 |

**0 2 . 1**

**Calculate the mass of ethanol that must be burned to release the same amount of energy as burning 1.00 g of heptanol. [2 marks]**

**Mass = ______________________ g**

**[Turn over]**

REPEAT OF TABLE 2

| Alcohol | Formula of one molecule of the alcohol | Energy released in kJ/g |
|---|---|---|
| Ethanol | $C_2H_5OH$ | 29.6 |
| Propanol | $C_3H_7OH$ | 33.6 |
| Butanol | $C_4H_9OH$ | 36.1 |
| Pentanol | $C_5H_{11}OH$ | 37.7 |
| Hexanol | $C_6H_{13}OH$ | 38.9 |
| Heptanol | $C_7H_{15}OH$ | 39.8 |

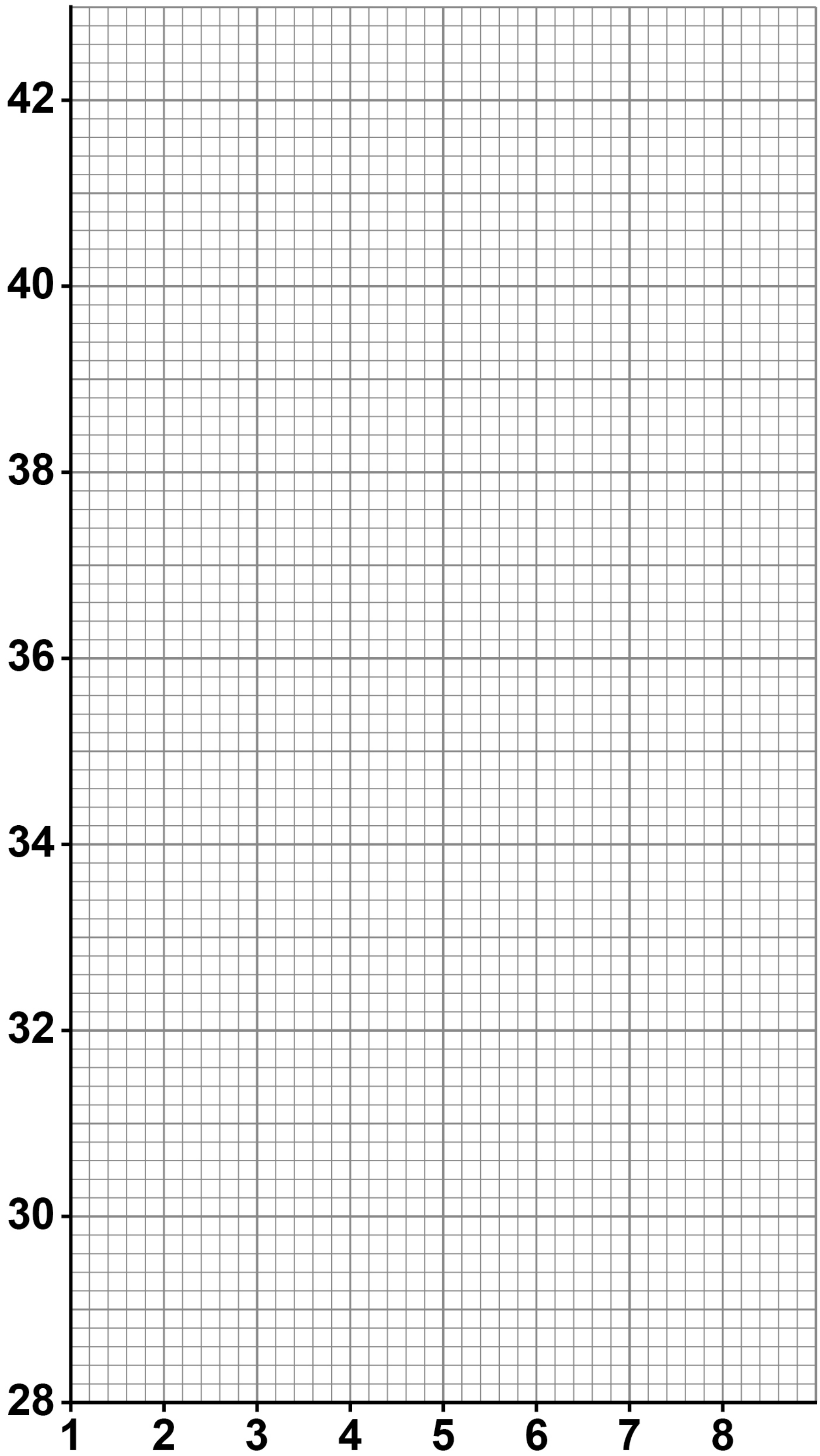
0 2 . 2

The energy released in kJ/g varies with the number of carbon atoms in one molecule of each alcohol.

Plot the data from TABLE 2 on FIGURE 2, on the opposite page. [2 marks]

**FIGURE 2**

**Energy released in kJ/g**




**Number of carbon atoms in one molecule of alcohol**

**[Turn over]**

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**0 2 . 3**

**Estimate the energy released in kJ when 1.00 g of octanol ($C_8H_{17}OH$) is burned.**

**Use FIGURE 2, on page 13. [1 mark]**

**Energy released = ______________________________ kJ**

**[Turn over]**

**Carbon dioxide is produced when alcohols are burned.**

**Carbon dioxide is identified by bubbling the gas through limewater.**

**0 2 . 4**

**Complete the sentence.**

**Choose the answer from the list. [1 mark]**

- **calcium chloride**
- **calcium hydroxide**
- **calcium nitrate**
- **calcium sulfate**

**Limewater is an aqueous solution of**

**________________________________________ .**

**02.5**

**Give the result of the test when carbon dioxide is bubbled through limewater. [1 mark]**

**[Turn over]**

**Ethanoic acid can be produced from ethanol.**

**0 2 . 6**

**What is reacted with ethanol to produce ethanoic acid?**
**[1 mark]**

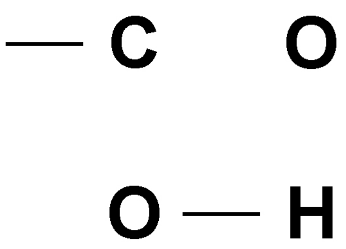
**Tick (✓) ONE box.**

- [ ] **A halogen**
- [ ] **An alkali metal**
- [ ] **An oxidising agent**
- [ ] **Water**

**0 2 . 7**

**Ethanoic acid contains the functional group –COOH**

**Complete the displayed structural formula of this functional group. [1 mark]**



**[Turn over]**

**0 2 . 8**

**Ethanoic acid reacts with different compounds.**

**Draw ONE line from each compound to a product of the reaction of the compound with ethanoic acid. [2 marks]**

| Compound | Product of the reaction with ethanoic acid |
|---|---|
| | Carbon dioxide |
| Ethanol | Ethene |
| | Ethyl ethanoate |
| Sodium carbonate | Hydrogen |
| | Poly(ethene) |

11

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**[Turn over]**

**0 3**

**This question is about chemical analysis.**

**Potassium bromide is used in medicine.**

**A scientist tested a sample of medicine to show the presence of potassium ions and of bromide ions.**

**The sample is soluble in water.**

**0 3 . 1**

**Plan a method the scientist could use to show that the sample of medicine contains potassium ions AND bromide ions.**

**The scientist has:**

- **a Bunsen burner**
- **a metal wire**
- **test tubes**
- **a dropping pipette**
- **distilled water**
- **dilute nitric acid**
- **silver nitrate solution.**

**You should give the results of the tests. [6 marks]**

[Turn over]

**The scientist could also use an instrumental method to show the presence of potassium ions in the medicine.**

**0 3 . 2**

**Which instrumental method could be used to show the presence of potassium ions in the medicine? [1 mark]**

**0 3 . 3**

**Give ONE advantage of using this instrumental method instead of a chemical test. [1 mark]**

**[Turn over]**

**8**

**0 4**

**This question is about greenhouse gases and climate change.**

**Carbon dioxide and methane are greenhouse gases.**

**0 4 . 1**

**Which of the following is also a greenhouse gas?**
**[1 mark]**

**Tick (✓) ONE box.**

- [ ] **Chlorine**
- [ ] **Nitrogen**
- [ ] **Oxygen**
- [ ] **Water vapour**

In the past 50 years, there has been an increase in:

- the world population
- the concentration of carbon dioxide in the atmosphere
- the concentration of methane in the atmosphere
- the mean temperature of the atmosphere at the Earth's surface.

Most scientists think this information can be used to explain climate change.

0 4 . 2

Explain why the increase in world population may have caused the increase in the concentration of carbon dioxide in the atmosphere. [2 marks]

**0 4 . 3**

**Explain why the increase in world population may have caused the increase in the concentration of methane in the atmosphere. [2 marks]**

0 4 . 4

**Describe TWO potential effects of the increase in the mean temperature of the atmosphere at the Earth's surface. [2 marks]**

1 ______________________________________________

______________________________________________

______________________________________________

2 ______________________________________________

______________________________________________

______________________________________________

**[Turn over]**

**0 4 . 5**

**The mean temperature of the atmosphere at the Earth's surface has increased.**

**Most scientists think that this has been caused by an increase in the concentration of greenhouse gases in the atmosphere.**

**Give ONE reason why some scientists do NOT accept this theory. [1 mark]**

**8**

**0 5**

Copper is extracted from metal ores.

Chalcopyrite is a metal ore containing a compound with the formula $CuFeS_2$

**0 5 . 1**

$CuFeS_2$ reacts with oxygen to produce copper(II) sulfate and iron(II) sulfate.

Complete the equation for this reaction.

You should balance the equation. [2 marks]

$CuFeS_2$ + ____________ $\longrightarrow$ $CuSO_4$ + $FeSO_4$

[Turn over]

**0 5 . 2**

**Calculate the percentage by mass of copper in $CuFeS_2$**

**Relative atomic masses ($A_r$):**

**S = 32 Fe = 56 Cu = 63.5**

**[3 marks]**

**Percentage by mass = ____________________ %**

**0 5 . 3**

**Describe a test to show the presence of copper(II) ions in a solution of copper(II) sulfate.**

**Give the result of the test. [2 marks]**

**Test** ____________________________________________

____________________________________________

____________________________________________

**Result** ____________________________________________

____________________________________________

____________________________________________

**[Turn over]**

**0 5 . 4**

**Copper can be extracted from low-grade ores by bioleaching.**

**Describe what is meant by bioleaching. [2 marks]**

**9**

**0 6**

**This question is about chromatography.**

**A student investigated an orange food colouring using two different types of chromatography paper.**

**The food colouring:**

- **contained a mixture of red and yellow dyes**
- **was soluble in water.**

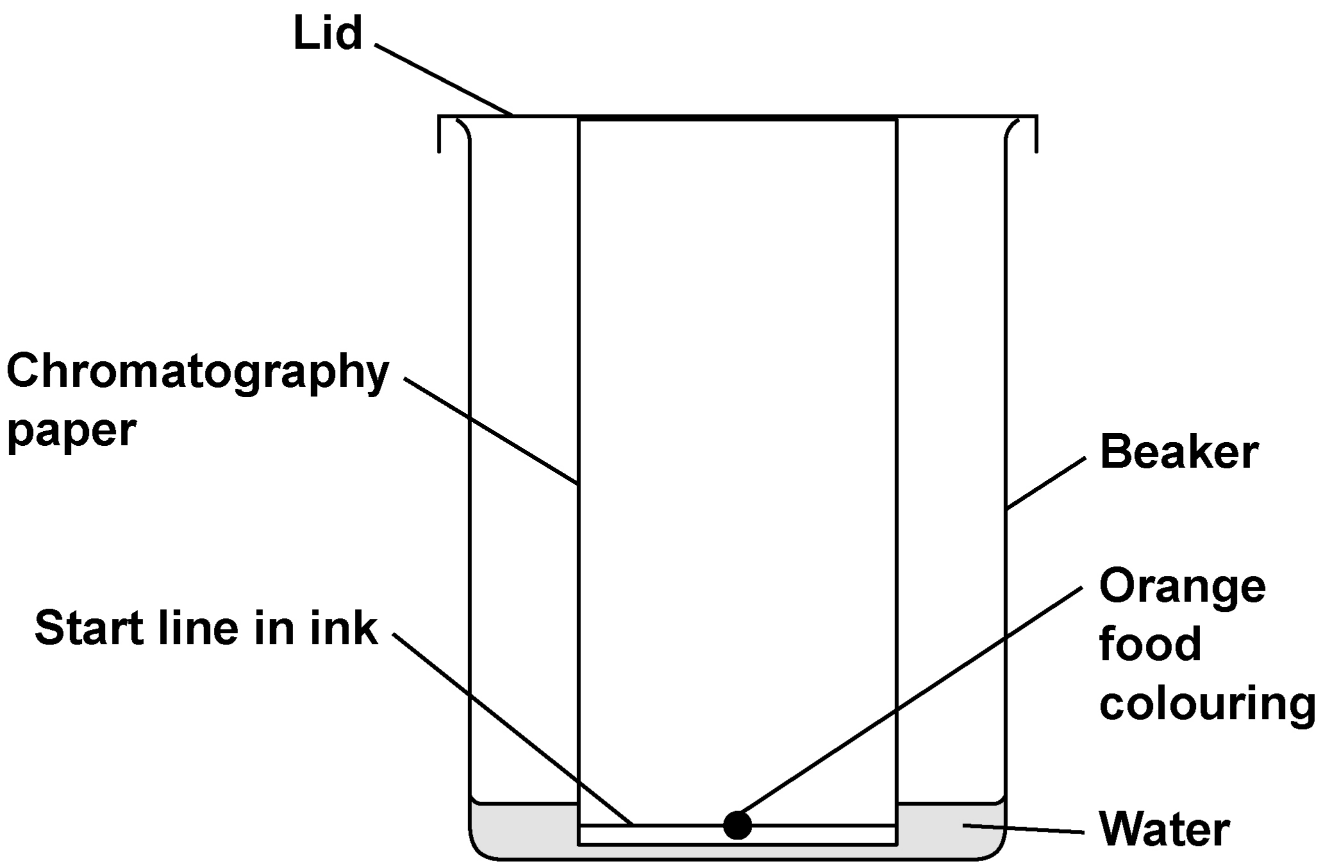
**This is the method used.**

1. **Draw a start line on a piece of type A chromatography paper.**
2. **Put a spot of orange food colouring on the line.**
3. **Put the paper into a beaker containing water as a solvent.**
4. **Wait for the water to travel up the paper.**
5. **Measure the distance above the start line moved by the red and yellow dyes and the water.**
6. **Repeat steps 1 to 5 using type B chromatography paper.**

**[Turn over]**

**FIGURE 3 shows how the student set up the apparatus.**

**FIGURE 3**



**0 6 . 1**

**The student made TWO mistakes when setting up the apparatus.**

**Give TWO mistakes the student made. [2 marks]**

**1** ______________________________________________

______________________________________________

______________________________________________

**2** ______________________________________________

______________________________________________

______________________________________________

**[Turn over]**

Another student set up the apparatus correctly.

TABLE 3 shows the results.

TABLE 3

| | Type A chromatography paper | | Type B chromatography paper | |
|---|---|---|---|---|
| | Red dye | Yellow dye | Red dye | Yellow dye |
| Distance moved by dye in cm | 4.8 | 6.6 | 5.4 | X |
| Distance moved by water in cm | 12.0 | 12.0 | 12.0 | 12.0 |
| $R_f$ value | 0.40 | 0.55 | 0.45 | 0.60 |

**0 6 . 2**

**Determine value X in TABLE 3. [3 marks]**

**X = ______________________________ cm**

**[Turn over]**

**Changing the type of chromatography paper resulted in different $R_f$ values for the red dye.**

**0 6 . 3**

**Explain why the $R_f$ values for the red dye are different using the two types of chromatography paper.**

**Use TABLE 3, on page 38. [3 marks]**

**06.4**

**What other change to the investigation could result in a different $R_f$ value for the red dye? [1 mark]**

**[Turn over]**

**9**

**07**

**Manganese dioxide catalyses the decomposition of hydrogen peroxide solution.**

**Oxygen and water are produced.**

**07.1**

**Explain how a manganese dioxide catalyst increases the rate of decomposition of hydrogen peroxide.**
**[2 marks]**

A student investigated the rate of this reaction.

This is the method used.

1. Add 50 $cm^3$ of 2.0 $mol/dm^3$ hydrogen peroxide solution to a conical flask.
2. Add 1.0 g of manganese dioxide to the conical flask.
3. Place the conical flask on a balance and start a timer.
4. Record the total mass lost from the conical flask every 20 seconds for 180 seconds.

**0 7 . 2**

Explain why the mass of the conical flask and contents decreased. [2 marks]

[Turn over]

**0 7 . 3**

**FIGURE 4, on the opposite page, shows the results for 50 $cm^3$ of 2.0 $mol/dm^3$ hydrogen peroxide solution and 1.0 g of manganese dioxide.**

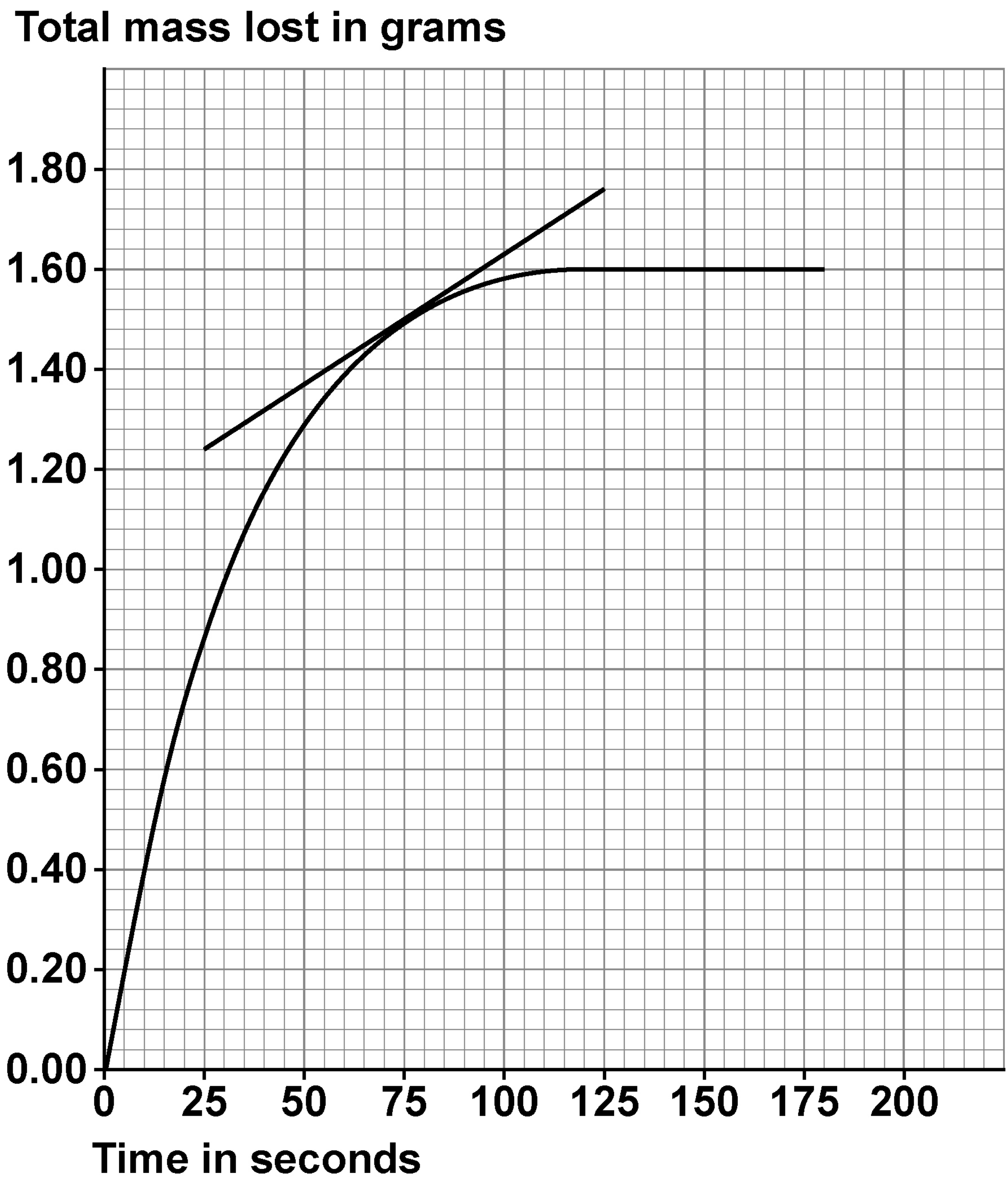
**A tangent to the line has been drawn at 75 seconds.**

**Determine the rate of reaction when the time was 75 seconds.**

**Give your answer to 2 significant figures. [4 marks]**

**Rate (2 significant figures) = ____________________ g/s**

FIGURE 4

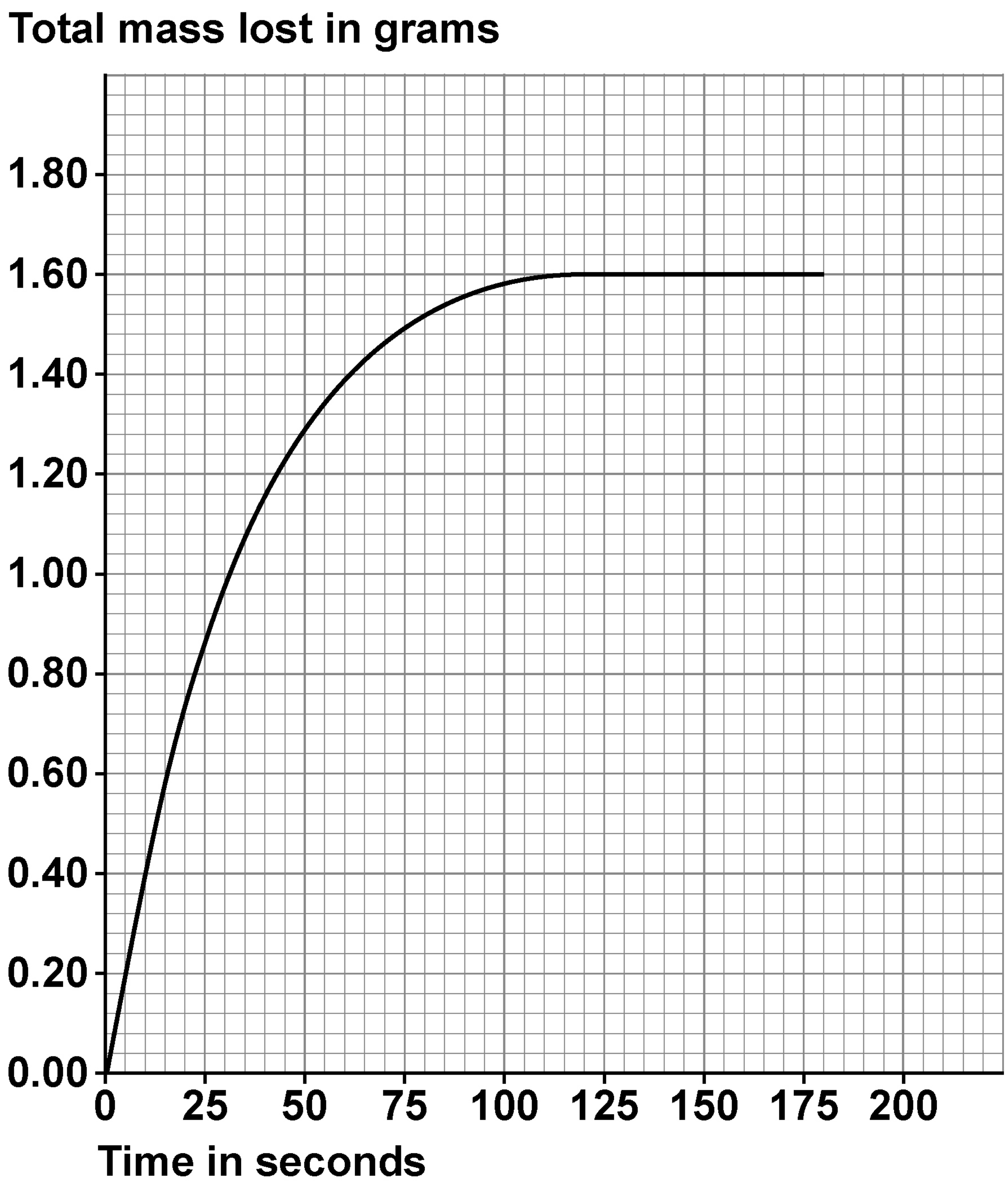



[Turn over]

**0 7 . 4**

**The results for 50 cm$^3$ of 2.0 mol/dm$^3$ hydrogen peroxide solution and 1.0 g of manganese dioxide are shown again on FIGURE 5.**

**FIGURE 5**



**The student repeated the investigation using 50 $cm^3$ of 1.0 mol/$dm^3$ hydrogen peroxide solution and 1.0 g of manganese dioxide.**

**Sketch the expected results for 1.0 mol/$dm^3$ hydrogen peroxide solution on FIGURE 5. [2 marks]**

**[Turn over]**

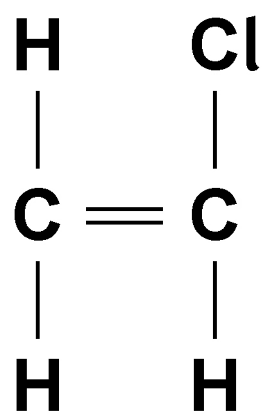
10

**0 8**

**This question is about polymers.**

**Chloroethene can be used to produce an addition polymer called poly(chloroethene).**

**The displayed structural formula of chloroethene is**

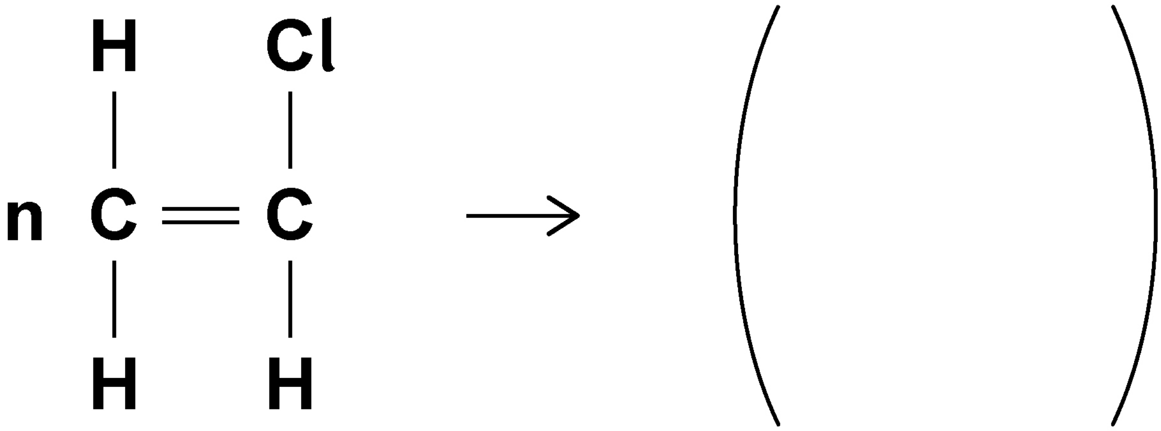



**0 8 . 1**

**Draw a circle around the functional group on the displayed structural formula that allows chloroethene to produce an addition polymer. [1 mark]**

**0 8 . 2**

**Complete the equation for the production of poly(chloroethene) from chloroethene. [3 marks]**



**0 8 . 3**

**Poly(ethene) can be strengthened with wood particles to make a building material.**

**The building material consists of a wood particle reinforcement embedded in a poly(ethene) matrix.**

**What general name is given to materials like this?**
**[1 mark]**

______________________________________________

**[Turn over]**

**0 8 . 4**

**The amino acid beta-alanine has the formula**

**$H_2NCH_2CH_2COOH$**

**Beta-alanine polymerises to produce a polypeptide and a small molecule.**

**Name the small molecule produced when beta-alanine polymerises. [1 mark]**

**0 8 . 5**

**An amino acid can be represented as:**


**The relative formula mass ($M_r$) of this amino acid is 75**

**Calculate the relative formula mass of the section of this amino acid molecule represented by**

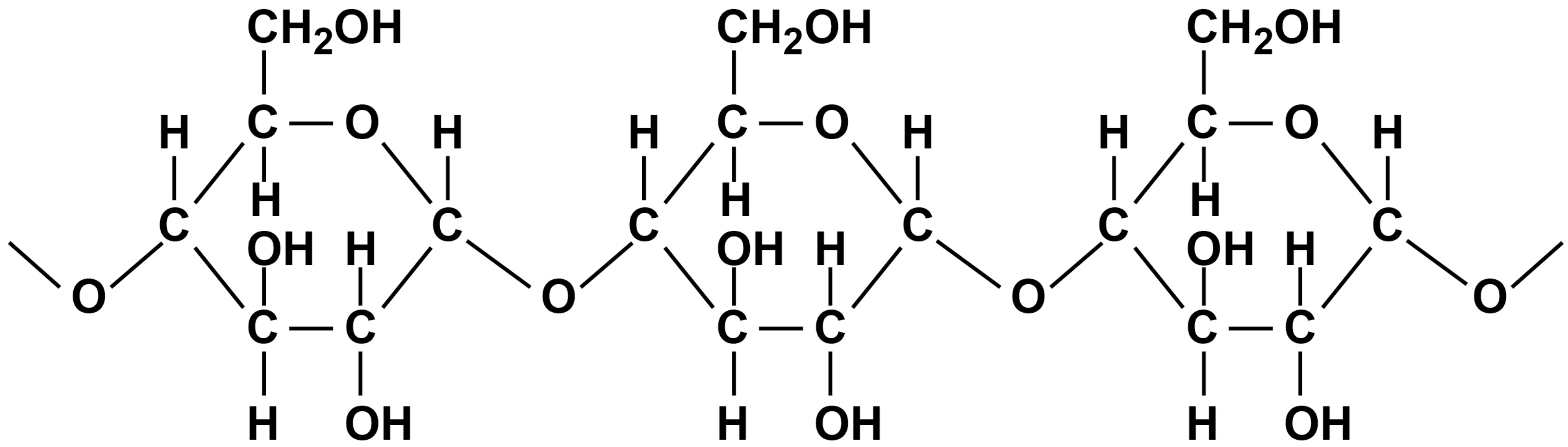
Relative atomic masses ($A_r$): H = 1 C = 12
N = 14 O = 16 [2 marks]

Relative formula mass =

[Turn over]

FIGURE 6 represents part of a naturally occurring polymer molecule produced from glucose.

FIGURE 6



**08.6**

Draw a circle around the repeating unit in the polymer in FIGURE 6. [1 mark]

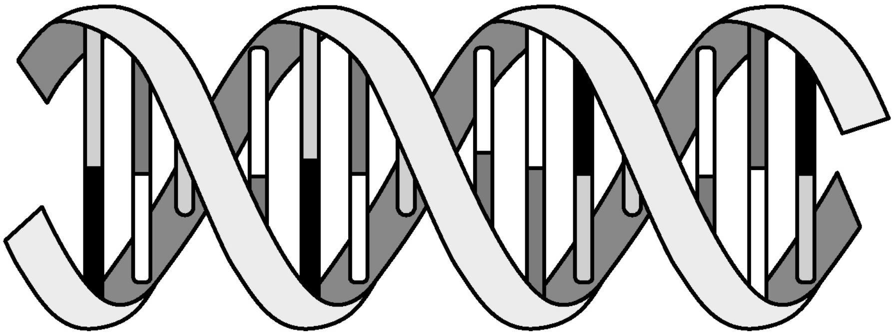
**0 8 . 7**

**Suggest the identity of this polymer.  [1 mark]**

**[Turn over]**

**FIGURE 7 represents the structure of a naturally occurring polymer.**

**FIGURE 7**



**0 8 . 8**

**Give the general name for the four different monomers which make up the structure shown in FIGURE 7.**
**[1 mark]**

---

**0 8 . 9**

**Name the SHAPE of the structure shown in FIGURE 7.**
**[1 mark]**

---

**12**

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[Turn over]

**0 9**

**This question is about reversible reactions.**

**When 4.68 g of hydrated copper sulfate changes into anhydrous copper sulfate:**

- **2.99 g of anhydrous copper sulfate is produced**
- **1.47 kJ of energy is taken in from the surroundings.**

**The equation for the reversible reaction is:**

**hydrated copper sulfate $\rightleftharpoons$**

**anhydrous copper sulfate + water**

**0 9 . 1**

**Calculate the maximum mass of water that can be produced from 11.7 g of hydrated copper sulfate.**
**[3 marks]**

Mass = ____________________ g

**[Turn over]**

**0 9 . 2**

**15.0 g of anhydrous copper sulfate completely changes into hydrated copper sulfate when water is added.**

**Calculate the amount of energy transferred to the surroundings. [2 marks]**

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

**Energy = ______________________ kJ**

**The gases nitrogen dioxide and dinitrogen tetroxide reach dynamic equilibrium in a sealed container.**

**The equation for the reaction is:**

| | | |
|---|---|---|
| **$2\ NO_2(g)$** | $\rightleftharpoons$ | **$N_2O_4(g)$** |
| **nitrogen dioxide (brown)** | | **dinitrogen tetroxide (colourless)** |

**The forward reaction is exothermic.**

**0 9 . 3**

**What happens to the position of the equilibrium in this reaction if the temperature is increased? [1 mark]**

**Tick (✓) ONE box.**

- [ ] **Shifts to the left**
- [ ] **Stays the same**
- [ ] **Shifts to the right**

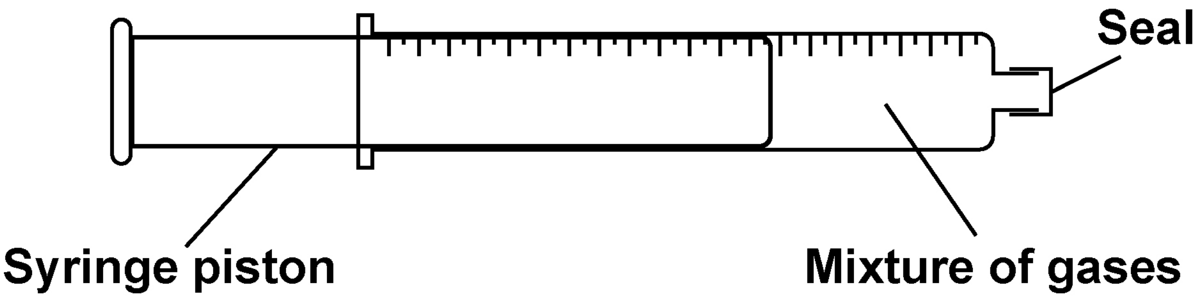
**[Turn over]**

0 9 . 4

**A teacher seals a brown-coloured mixture of nitrogen dioxide and dinitrogen tetroxide in a gas syringe.**

**FIGURE 8 shows the sealed gas syringe.**

**FIGURE 8**




**The teacher pushes the syringe piston in.**

**This increases the pressure in the gas syringe.**

**What is the colour of the mixture when a new equilibrium position is reached? [1 mark]**

**Tick (✓) ONE box.**

☐ **The mixture is a darker shade of brown.**

☐ **The mixture is the same shade of brown.**

☐ **The mixture is a lighter shade of brown.**

**[Turn over]**

Hydrogen iodide gas decomposes into hydrogen gas and iodine gas at high temperatures.

The equation for the reaction is:

$$2\,HI(g) \rightleftharpoons H_2(g) + I_2(g)$$

**0 9 . 5**

Explain the effect of increasing the pressure on the equilibrium position of this reaction. [2 marks]

**0 9 . 6**

**Suggest the effect of adding a catalyst on the equilibrium position of this reaction.  [1 mark]**

**[Turn over]**

Copper forms coloured compounds.

Hydrochloric acid is added to an aqueous solution of copper compound A.

The word equation for the reaction is:

| | | | | | | |
|---|---|---|---|---|---|---|
| copper compound A | + | hydrochloric acid | $\rightleftharpoons$ | copper compound B | + | water |
| (blue) | | | | (yellow) | | |

**0 9 . 7**

The reaction mixture is green when both copper compounds are present in a solution at equilibrium.

How can the equilibrium position be shifted to make the reaction mixture more yellow? [1 mark]

Tick (✓) ONE box, on the opposite page.

☐ **Add more hydrochloric acid**

☐ **Add more water**

☐ **Leave the reaction mixture for 30 minutes**

**[Turn over]**

**0 9 . 8**

**The concentrations of the substances in this reaction do NOT change at dynamic equilibrium.**

**Explain why. [2 marks]**

**13**

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[Turn over]

**1 0**

**This question is about fertilisers.**

**Compounds of nitrogen (N), phosphorus (P) and potassium (K) are used as fertilisers to improve agricultural productivity.**

**TABLE 4 shows information about three compounds, A, B and C, that can be used as fertilisers.**

**TABLE 4**

| | Compound A | Compound B | Compound C |
|---|---|---|---|
| Name | potassium chloride | ammonium nitrate | diammonium hydrogen phosphate |
| Formula | $KCl$ | $NH_4NO_3$ | $(NH_4)_2HPO_4$ |
| Percentage (%) of N, P and K by mass | K: 52% | N: 35% | N: 21%<br>P: 23% |
| Cost in £/kg | 0.24 | 0.23 | 0.35 |

**10.1**

**A scientist analysed the percentages of nitrogen, phosphorus and potassium in a soil.**

**The percentages of nitrogen and of potassium in the soil were lower than the percentages needed for high agricultural productivity.**

**There was sufficient phosphorus in the soil for high agricultural productivity.**

**Evaluate the use of the compounds in TABLE 4 to improve the agricultural productivity of this soil.**
**[4 marks]**

**[Turn over]**

**10.2**

**How is potassium chloride (compound A) obtained from the Earth? [1 mark]**

**10.3**

**Name ONE other compound that could be used instead of potassium chloride (compound A) to give a similar improvement in agricultural productivity. [1 mark]**

______________________________

**10.4**

**Nitric acid is needed to produce ammonium nitrate (compound B).**

**Name a compound needed to produce nitric acid. [1 mark]**

______________________________

**[Turn over]**

**10.5**

**Phosphate rock contains phosphorus compounds.**

**Plants absorb phosphorus from compounds dissolved in rainwater.**

**Suggest why phosphate rock CANNOT be used directly as a fertiliser. [1 mark]**

**10.6**

**Phosphate rock can be treated with different acids to produce salts useful as fertilisers.**

**Name the salts which are produced by treating phosphate rock with:**

- **sulfuric acid**
- **phosphoric acid.**

**[2 marks]**

**Sulfuric acid**

______________________________________________

**Phosphoric acid**

______________________________________________

**END OF QUESTIONS**

**10**

**Additional page, if required.**

**Write the question numbers in the left-hand margin.**

**Additional page, if required.**

**Write the question numbers in the left-hand margin.**

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| For Examiner's Use | |
|---|---|
| Question | Mark |
| 1 | |
| 2 | |
| 3 | |
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| 8 | |
| 9 | |
| 10 | |
| **TOTAL** | |